

Wrist Complex

(Distal Radioulnar, Wrist and Hand Joints)

Dr. Ghada S. M. Omar

**Assistant Prof. Princes Noura University
Faculty of Physical Therapy**

3-01-1433

1

Objectives

After studying this topic, the students will be able to:

1. Identify the structure of the wrist and hand, including joint type, articular shape, and the surrounding tissues.
2. Describe joint motions occurring at the wrist and hand, including movements, muscle actions, and factors affecting motions and stability.
3. Understand the stability mechanism of the wrist complex and the possible mechanisms of injury.

3-01-1433

2

Functions of the wrist and hand complex

Function of the wrist

The three major functions of the wrist joints are:-

- To allow fine hand and finger functions.
- To control length/ tension of finger long flexors and extensors tendons.
- To provide stability for skilled or forceful hand movements.

Function of the hand

- to manipulate delicate fine motions.
- to complete powerful grasp tasks.
- to support or transfer force for changing positions.
- to serve as an sensory organ for perception of the surroundings.
- to help to express emotions.

3-01-1433

3

The wrist & hand Joints

- Many sports require precise functioning of wrist & hand
- Archery, bowling, golf, baseball, tennis, etc. require combined use of wrist & hand joints
- Relate functional anatomy to joint actions
 - flexion, extension, abduction, & adduction of wrist & hand
 - 29 bones
 - More than 25 joints
 - More than 30 muscles
 - 18 are intrinsic



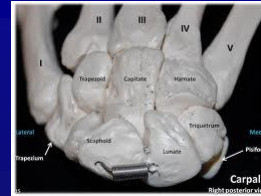
3-01-1433

4

Structure of the Wrist (Bones)

Eight carpal bones

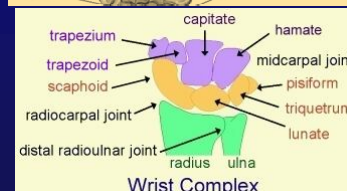
- Proximal row from radial to ulnar side
 - scaphoid (boat-shaped) or navicular
 - lunate (moon-shaped)
 - triquetrum (three-cornered)
 - pisiform (pea-shaped)
- Distal row, from the radial to ulnar side
 - trapezium (greater multangular)
 - trapezoid (lesser multangular)
 - Capitate
 - hamate (hooked)
- NO muscles inserted into the proximal carpal row.



3-01-1433

Bones

- Key distal bony landmarks for muscles involved in wrist motion
 - base of 2nd, 3rd, & 5th metacarpals, pisiform, & hamate
- Key bony landmarks for finger muscles
 - base of proximal, middle, & distal phalanxes.
 - base of 1st metacarpal, proximal & distal phalanxes of thumb.

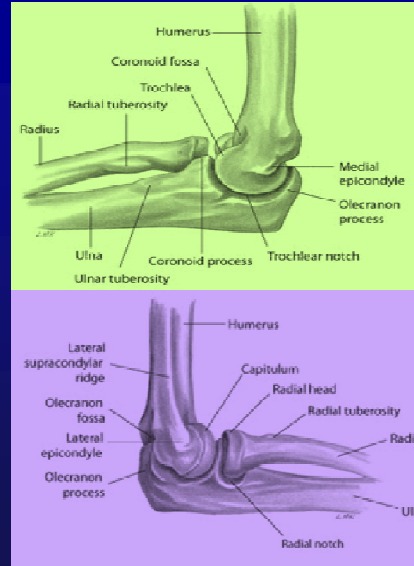


3-01-1433

6

Bones

- Key bony landmarks for wrist & hand muscles
 - medial epicondyle, medial condyloid ridge & coronoid process - origin for many wrist & finger flexors.
 - lateral epicondyle & lateral supracondylar ridge - origin for many wrist & finger extensors.



3-01-1433

7

Joint Structure of the Wrist Complex

Joints at wrist are:

- radiocarpal joint : primary joint for wrist extension
- midcarpal joint : primary joint for wrist flexion
- intercarpal joints
- distal radioulnar joint : forearm pronation/ supination

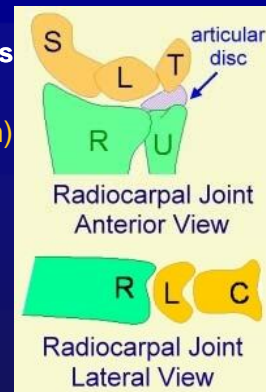


3-01-1433

8

Radiocarpal joint

- **Proximal component: biconcave distal end of the radius and articular disc**
 - the carpal bones only articulate with the radius
- **Distal component: biconvex proximal row of the carpal bones (scaphoid, Lunate & triquetrum)**
- joint type
 - convex on concave
- **motion :**
 - elbow flexion/ extension with dorsal/ palmar glide of the proximal row of the carpal bones on the distal radius.
 - wrist radial/ ulnar deviation with ulnar/ radial glide of the proximal row of the carpal bones on the distal radius

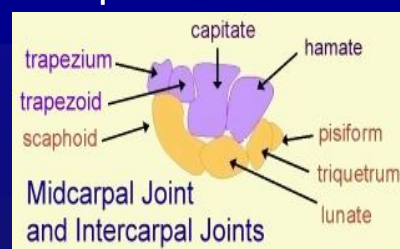


3-01-1433

9

Midcarpal joint

- trapezoid and trapezium on scaphoid
- capitate on scaphoid
- capitate on lunate
- capitate on triquetrum
- hamate on triquetrum



Intercarpal joint

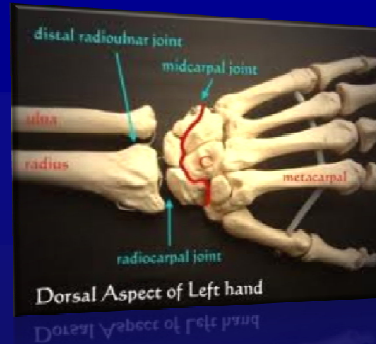
- trapezoid on capitate
- hamate on capitate
- pisiform on triquetrum

3-01-1433

10

Distal radioulnar joint

- **Proximal component : Ulna**
 - convex ulnar head
- **Distal component : Radius**
 - concave ulnar notch of the radius
- **Joint type**
 - pivot joint
- **Motion:**
 - forearm pronation/ supination
 - forearm pronation with anterior glide of the radial head
 - forearm supination with posterior glide of the radial head
- **NOTE:** It has different synovial joint from the radiocarpal joint.
- **DOF = 1**

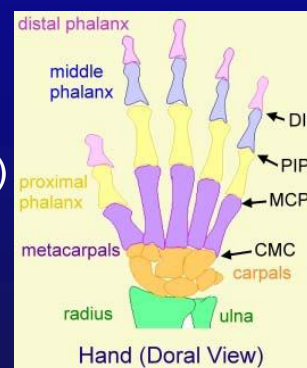


3-01-1433

11

Joint Structure of the Hand

- 5 carpometacarpal joints (CMC)
- 3 intermetacarpal joints (IMC)
- 5 Metacarpophalangeal joints (MCP)
- 4 proximal interphalangeal joints (PIP)
- 5 distal interphalangeal joints (DIP)
- composed of 19 bones, 5 digital rays, 29 muscles, and 14 joints

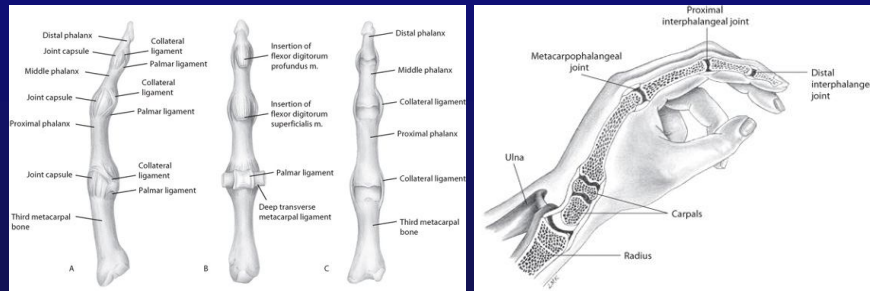


3-01-1433

12

Hand Joints

- Each finger has 3 joints
 - Metacarpophalangeal (MCP) joints
 - Proximal interphalangeal (PIP) joints
 - Distal interphalangeal (DIP) joints

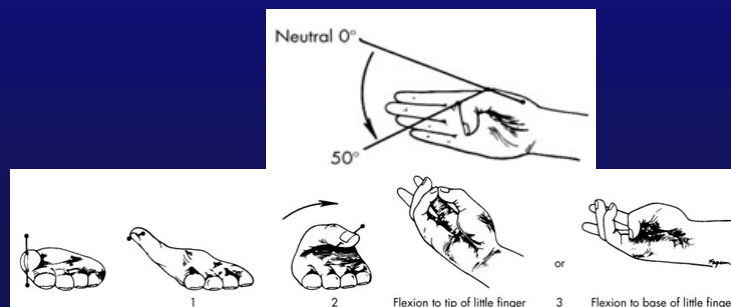


3-01-1433

13

Hand Joints

- Thumb has 3 joints
 - Metacarpophalangeal (MCP) joint
 - Full extension into 40 to 90 degrees of flexion
 - Ginglymus (**hinge joint**)

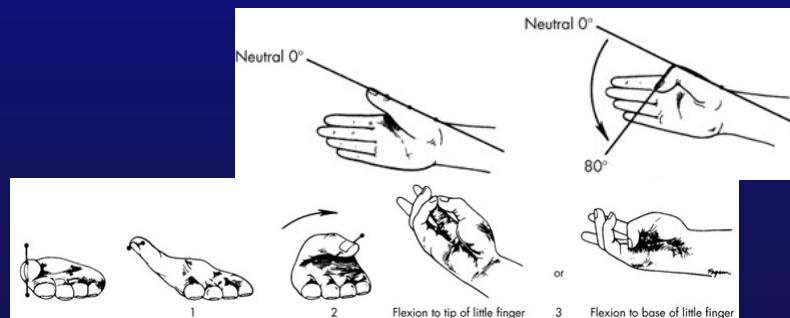


3-01-1433

14

Hand Joints

- Thumb has 3 joints
 - Interphalangeal (IP) joint
 - Flex 80 to 90 degrees
 - Ginglymus (**hinge joint**)

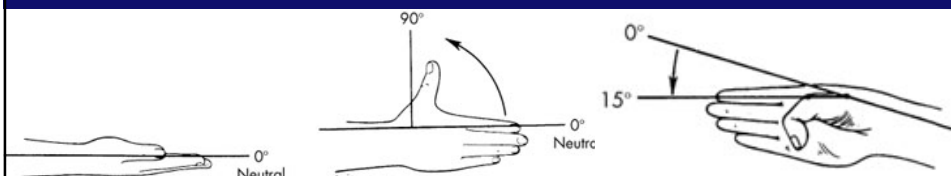


3-01-1433

15

Hand Joints

- Thumb has 3 joints
 - Carpometacarpal (CMC) joint of thumb
 - Unique saddle-type joint
 - 50 to 70 degrees of abduction
 - Flex 15 to 45 degrees & extend 0 to 20 degrees

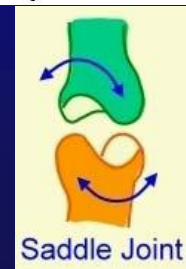
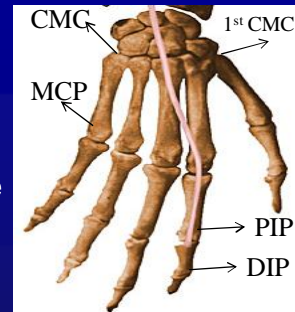


3-01-1433

16

First carpometacarpal (1st CMC) joint

- **Proximal component** : two trapezii
 - trapezoid
 - trapezium
- **Distal component**: first metacarpal base
- **Joint type**
 - saddle joint
- **Motion**:
 - flexion/ extension: concave first metatarsal base moving on convex trapezii
 - Abduction/ adduction: convex first metatarsal base moving on concave trapezii
- **DOF = 2**

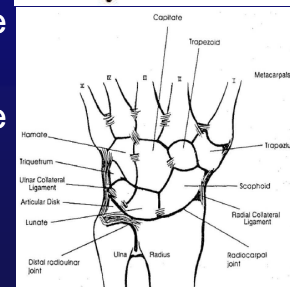
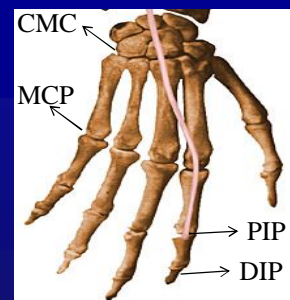


3-01-1433

17

Other carpometacarpal (CMC) joints

- **2nd CMC** : 2nd metacarpal on trapezoid (principal), trapezium, and capitate
- **3rd CMC** : 3rd metacarpal on capitate
- **4th CMC** : 4th metacarpal on hamate (principal) and capitate
- **5th CMC** : 5th metacarpal on hamate
- **Function** : to allow the hand to fit around any object, e.g. holding a ball

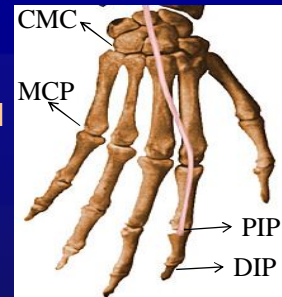


3-01-1433

18

Metacarpophalangeal (MCP) joints

- **Proximal component** : head of the metacarpal bone
- **Distal component**: base of the proximal phalanx
- **Joint type**
 - condyloid joint
- **Motion:**
 - flexion/ extension: concave proximal phalangeal base moving on convex metacarpal head
 - Abduction/ adduction: concave proximal phalangeal base moving on convex metacarpal head
- **DOF = 2**

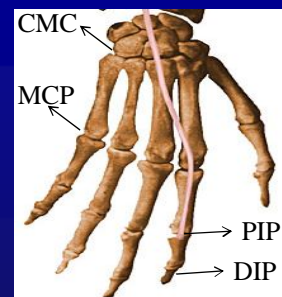


3-01-1433

19

Proximal interphalangeal (PIP) joints

- **Proximal component** : head of the proximal phalanx
- **Distal component**: base of the middle phalanx
- **Joint type**
 - Hinged joint
- **Motion:**
 - flexion/ extension: concave middle phalangeal base moving on convex proximal phalangeal head .
- **DOF = 1**

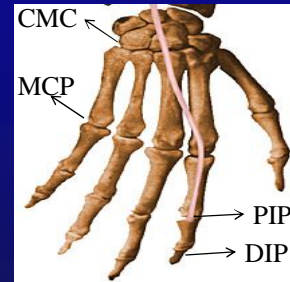


3-01-1433

20

Distal interpalangeal (DIP) joints

- **Proximal component** : head of the middle phalanx
- **Distal component**: base of the distal phalanx
- **Joint type**
 - Hinged joint
- **Motion:**
 - flexion/extension: concave distal phalangeal base moving on convex middle phalangeal .
- **DOF = 1**

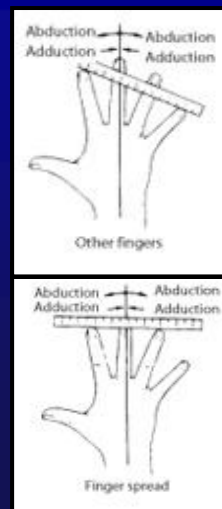


3-01-1433

21

Wrist and hand joints kinematics Wrist and Hand Movements

- **Wrist**
 - Flexion & extension
 - Abduction & adduction
- **Fingers**
 - Flexion & extension
 - MCP joints also abduct & adduct
- **Thumb**
 - Flexion & extension
 - Abduction & adduction
 - Opposition/reoposition

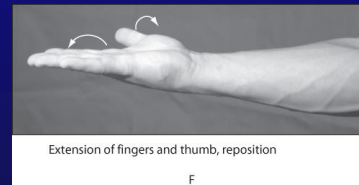
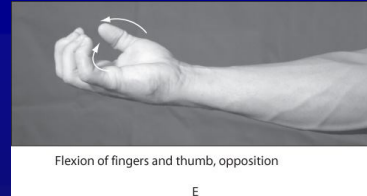


3-01-1433

22

Movements at wrist & hand joints

- Opposition
 - movement of thumb across palmar aspect to oppose any or all of the phalanges
- Reposition
 - movement of thumb as it returns to anatomical position from opposition with hand and/or fingers

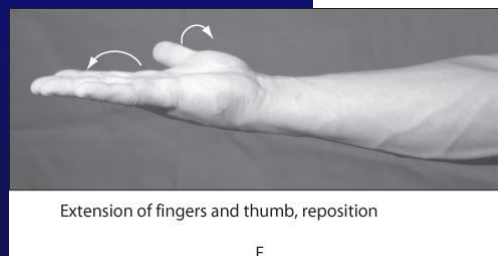
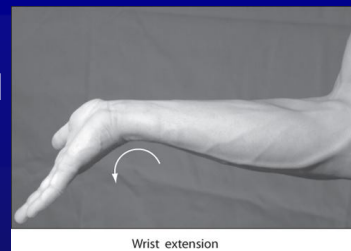


3-01-1433

23

Movements at wrist & hand joints

- Extension
 - movement of back of hand and/or phalanges toward posterior or dorsal aspect of forearm

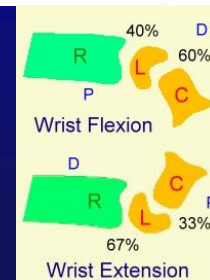
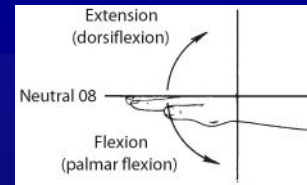


3-01-1433

24

Wrist flexion and extension

- **Wrist joint moves:**
 - 0 to 70 - 90 degrees of flexion
 - 0 to 65 - 85 degrees of extension
- **Joint involved in:**
 - Wrist flexion (radiocarpal joint: 40% / midcarpal joint: 60%)
 - Wrist extension (radiocarpal joint: 67% / midcarpal joint: 33%)
- **Plane of motion :** Sagittal plane

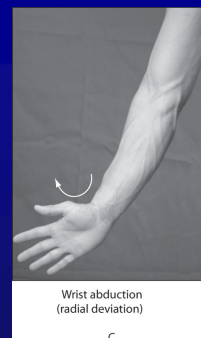


3-01-1433

25

Movements at wrist & hand joints

- **Abduction (radial flexion)**
 - movement of thumb side of hand toward lateral aspect or radial side of forearm
 - Also, movement of fingers away from middle finger



3-01-1433

26

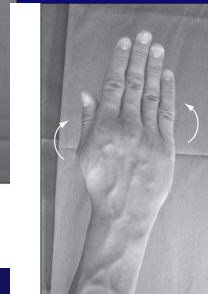
Movements at wrist & hand joints

- Adduction (ulnar flexion)
 - movement of little finger side of hand toward medial aspect or ulnar side of forearm
 - Also, movement of fingers toward middle finger



Wrist adduction (ulnar deviation)

D



Adduction of metacarpophalangeal joints and the thumb

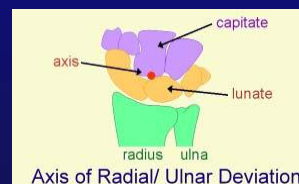
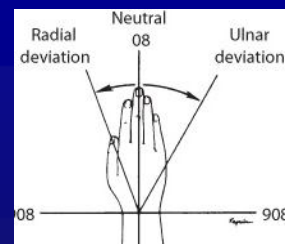
G

3-01-1433

27

Wrist adduction and abduction

- Wrist joint moves:
 - 15 to 25 degrees of abduction
 - 25 to 40 degrees of adduction
- Joint involved in:
 - Wrist radial deviation (abduction)
 - most in midcarpal joint (15°)
 - radiocarpal joint
 - intercarpal joints
 - Wrist ulnar deviation (adduction)
 - most in radiocarpal joint (30°)
 - midcarpal joint
 - intercarpal joints
- Plane of motion : Frontal plane

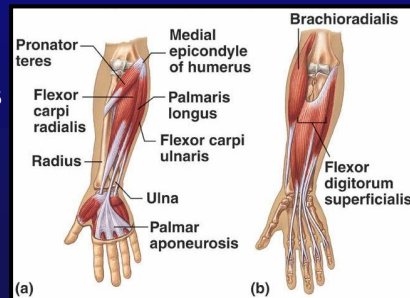
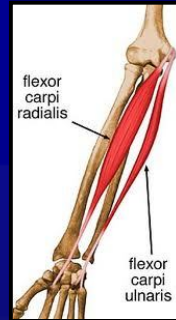


3-01-1433

28

Wrist Musculature

- Primary Wrist Flexors
 - Flexor Carpi Radialis
 - Flexor Carpi Ulnaris
- Secondary Wrist Flexors
 - Palmaris Longus
 - Flexor Digitorum Profundus (FDP)
 - Flexor Digitorum superficialis (FDS)
 - Flexor Pollicis Longus

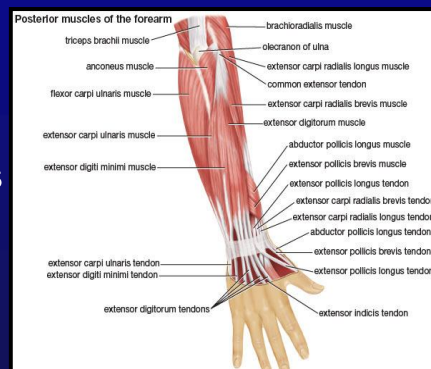


3-01-1433

29

Wrist Musculature

- Primary Wrist Extensors
 - Extensor Carpi Radialis Longus/Brevis
 - Extensor Carpi Ulnaris
- Secondary Wrist Extensors
 - Extensor Digitorum
 - Extensor Indicis
 - Extensor Digit Minimi

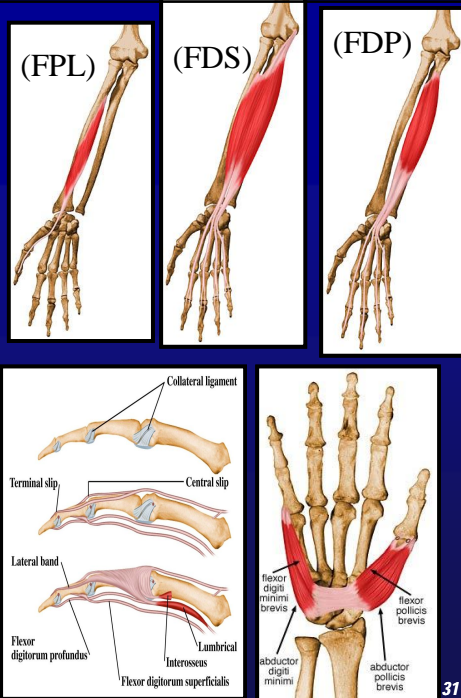


3-01-1433

30

Hand Musculature

- Hand Flexors
 - Flexor Digitorum Profundus (FDP)
 - Flexor Digitorum Superficialis (FDS)
 - Flexor Pollicis Longus (FPL)
 - Flexor Pollicis Brevis (FPB)
 - Flexor Digit Minimi Brevis
 - Lumbricales



3-01-1433

31

Hand Muscles

- Hand Extensors
 - Extensor Pollicis Longus/Brevis
 - Extensor Indicis
 - Lumbricales



3-01-1433

32

Intrinsic Muscles of the Hand

- Radial side - four muscles of the thumb
 - opponens pollicis
 - abductor pollicis brevis
 - flexor pollicis brevis
 - adductor pollicis
- Ulnar side - three muscles of little finger
 - opponens digiti minimi
 - abductor digiti minimi
 - flexor digiti minimi brevis
- Remainder of hand - 11 different muscles
 - 4 lumbricals
 - 3 palmar interossei
 - 4 dorsal interossei



3-01-1433

33

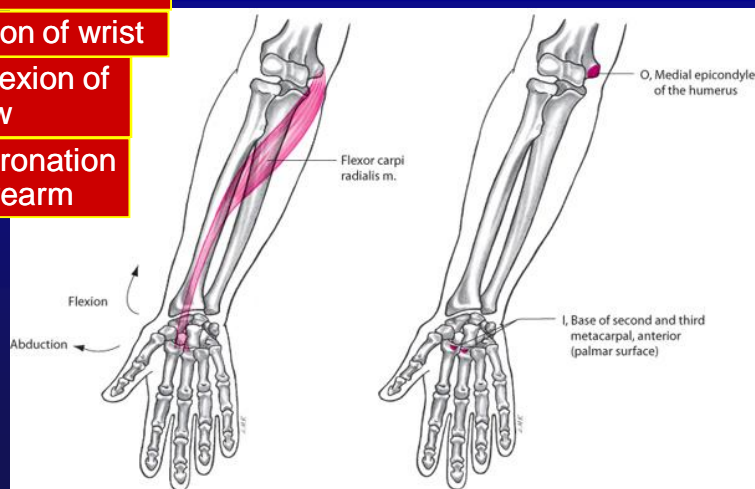
Flexor Carpi Radialis Muscle

Flexion of wrist

Abduction of wrist

Weak flexion of elbow

Weak pronation of forearm



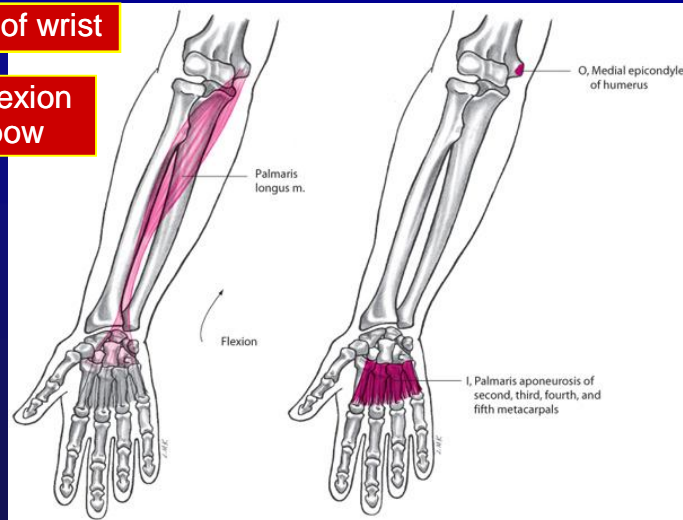
3-01-1433

34

Palmaris Longus Muscle

Flexion of wrist

Weak flexion
of elbow



3-01-1433

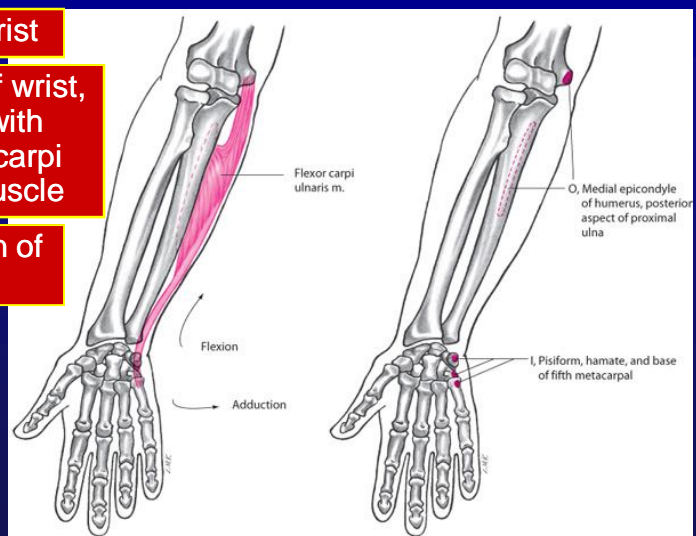
35

Flexor Carpi Ulnaris Muscle

Flexion of wrist

Adduction of wrist,
together with
extensor carpi
ulnaris muscle

Weak flexion of
elbow



3-01-1433

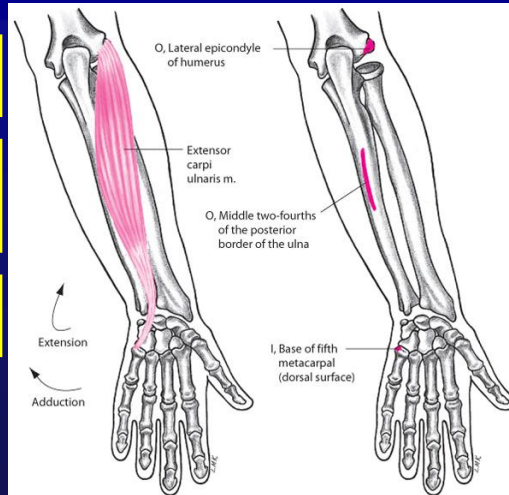
36

Extensor Carpi Ulnaris Muscle

Extension of wrist

Adduction of wrist together with flexor carpi ulnaris muscle

Weak extension of elbow



3-01-1433

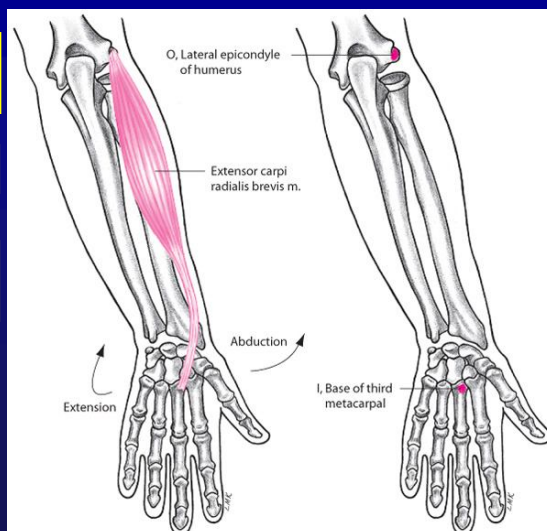
37

Extensor Carpi Radialis Brevis Muscle

Extension of wrist

Abduction of wrist

Weak flexion of elbow



3-01-1433

38

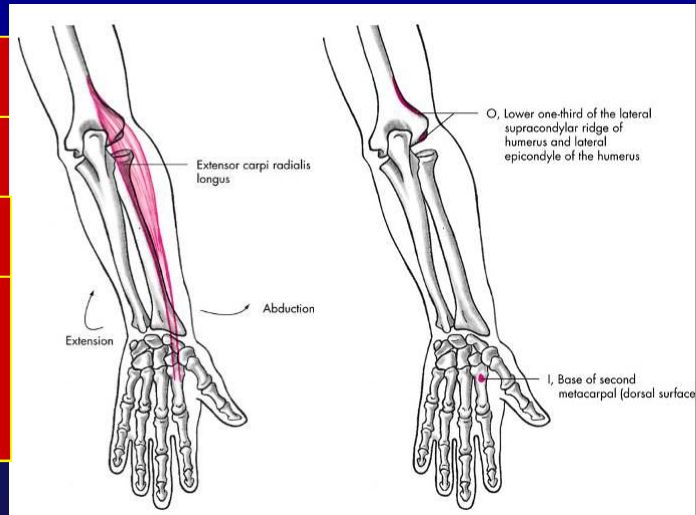
Extensor Carpi Radialis Longus Muscle

Extension of wrist

Abduction of wrist

Weak flexion of elbow

Weak pronation to neutral from a fully supinated position



3-01-1433

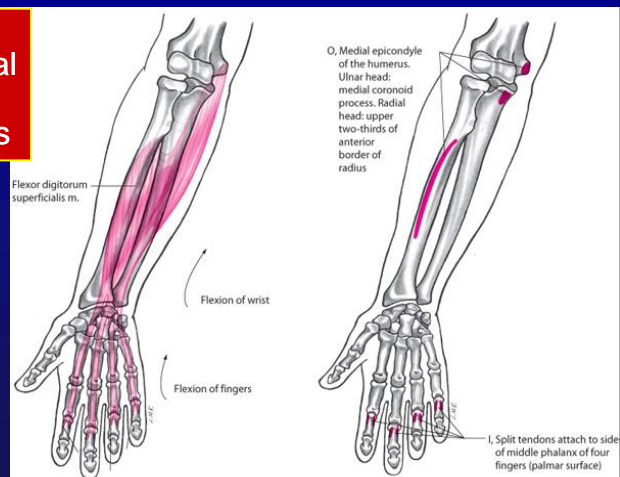
39

Flexor Digitorum Superficialis Muscle

Flexion of fingers at metacarpophalangeal & proximal interphalangeal joints

Flexion of wrist

Weak flexion of elbow



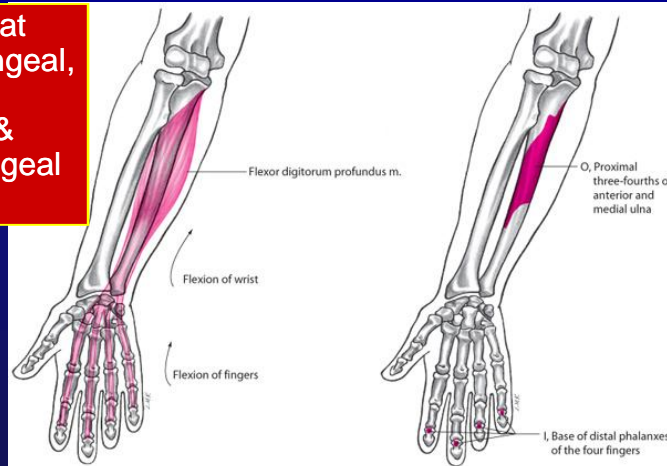
3-01-1433

40

Flexor Digitorum Profundus Muscle

Flexion of 4 fingers at metacarpophalangeal, proximal interphalangeal, & distal interphalangeal joints

Flexion of wrist



3-01-1433

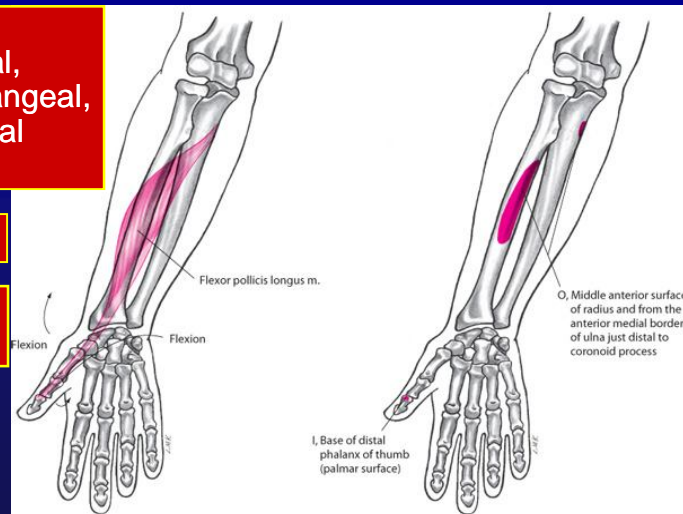
41

Flexor Pollicis Longus Muscle

Flexion of thumb carpometacarpal, metacarpophalangeal, & interphalangeal joints

Flexion of wrist

Abduction of wrist



3-01-1433

42

Extensor Digitorum Muscle

Extension of 2nd, 3rd, 4th, & 5th phalanges at metacarpophalangeal joints

Extension of wrist

Weak extension of elbow



Origin:
Posteriolateral humeral epicondyle

Insertion:
Base of dorsal aspect of middle & distal phalanges

3-01-1433

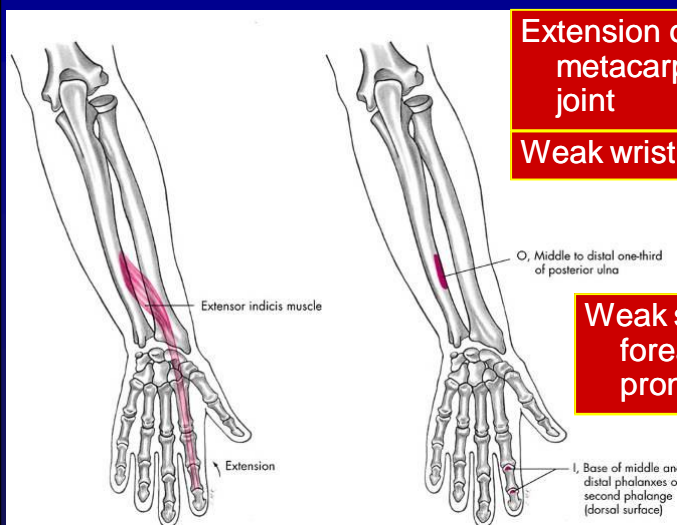
43

Extensor Indicis Muscle

Extension of index finger at metacarpophalangeal joint

Weak wrist extension

Weak supination of forearm from a pronated position



3-01-1433

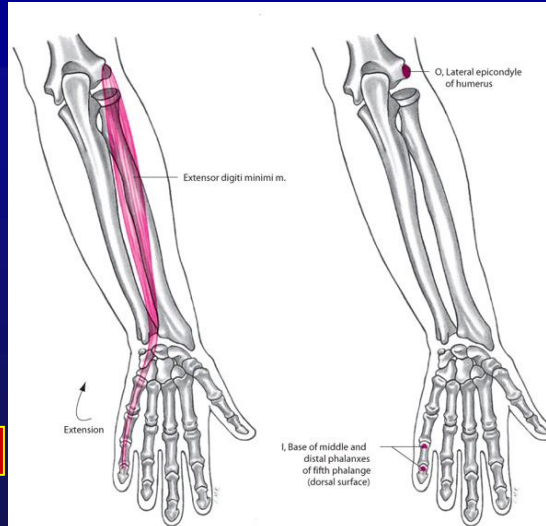
44

Extensor Digiti Minimi Muscle

Extension of little finger
at
metacarpophalangeal
joint

Weak wrist extension

Weak elbow extension



3-01-1433

45

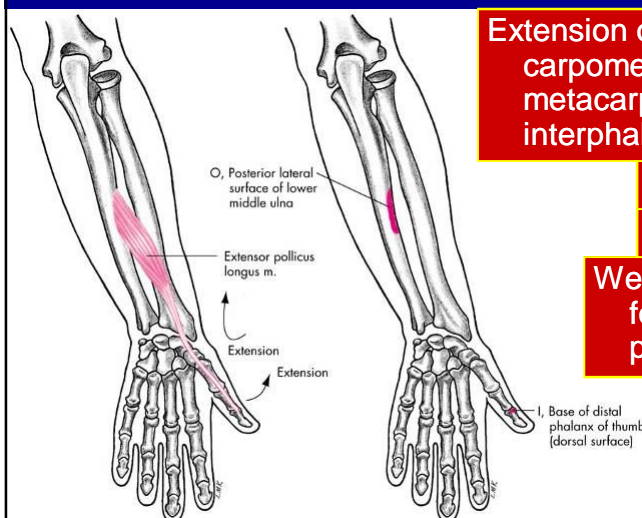
Extensor Pollicis Longus Muscle

Extension of thumb at
carpometacarpal,
metacarpophalangeal, &
interphalangeal joint

Extension of wrist

Abduction of wrist

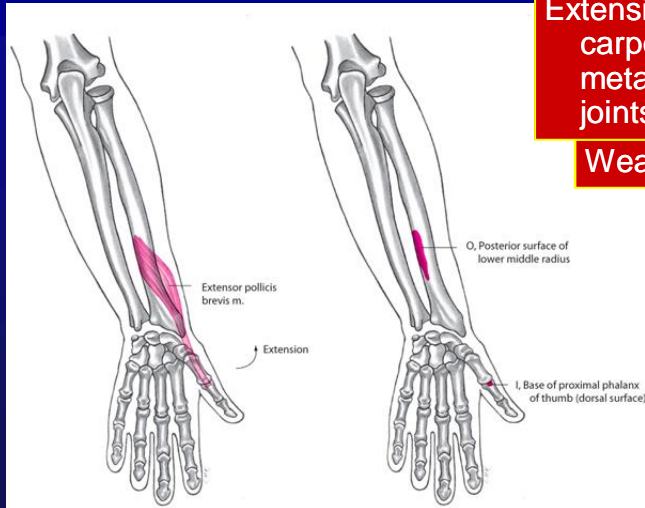
Weak supination of
forearm from a
pronated position



3-01-1433

46

Extensor Pollicis Brevis Muscle



Extension of thumb at
carpometacarpal &
metacarpophalangeal
joints

Weak wrist extension

Wrist abduction

3-01-1433

47

Abductor Pollicis Longus Muscle

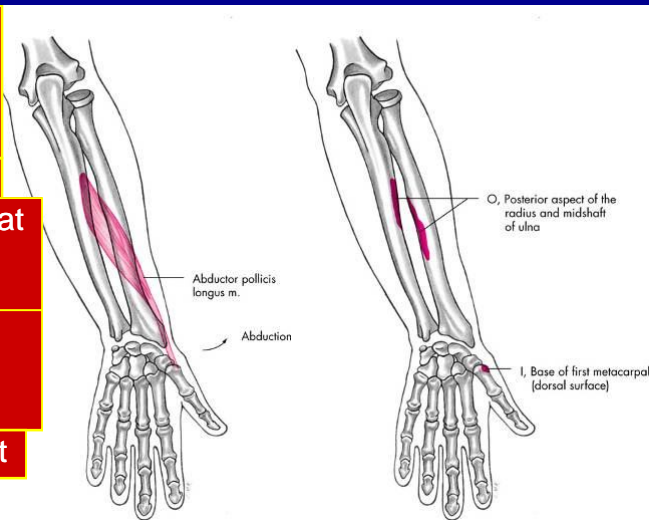
Abduction of thumb
at
carpometacarpal
joint

Abduction of wrist

Extension of thumb at
carpometacarpal
joint

Weak supination of
forearm from a
pronated position

Weak flexion of wrist

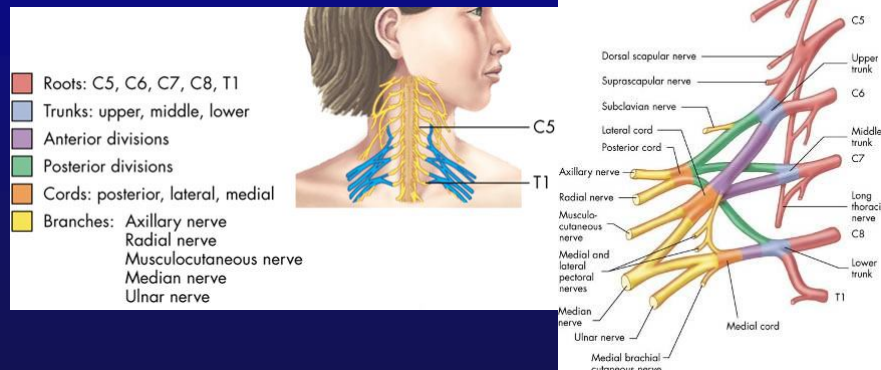


3-01-1433

48

Nerves

- All wrist & hand muscles are innervated from the radial, median, & ulnar nerves of the brachial plexus



3-01-1433

49

Stability of the Wrist joints

- **Bony configuration:** most important
- **Tension of ligaments:**
 - extrinsic and intrinsic ligaments
 - anterior and posterior radiocarpal ligaments
 - radial collateral ligament: prevents ulnar deviation stress
 - ulnar collateral ligament: prevents radial deviation stress
 - interosseous membrane
- **Muscle arrangement:**
 - no muscle inserts on carpals excepts flexor carpi ulnaris

Stability of the distal radioulnar joint

- **Bony configuration**
- **Interosseous membrane**

3-01-1433

50

Mechanism of Injury at the Wrist

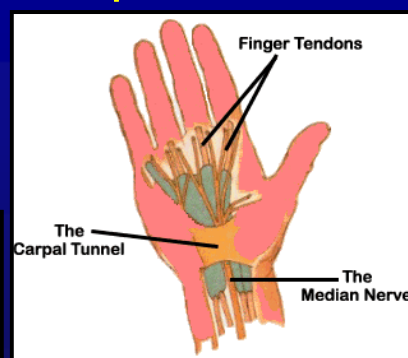
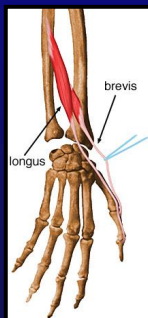
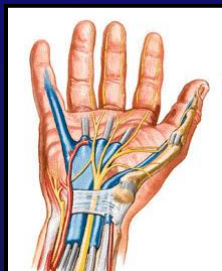
- **Direct stress**
 - compression stress such as Colles' fracture (distal radius fracture) with/ without dorsal displacement.
- **Repeated stresses**
 - repeated wrist flexion/extension motion resulting in chronic tenosynovitis of common flexor tendon or carpal tunnel syndrome.
 - repeated radial/ulnar deviation motion resulting in chronic tenosynovitis of extensor pollicis brevis and/or abductor pollicis longus or deQuervain syndrome

3-01-1433

51

Closer Look at the Carpal Tunnel

- **Structures within Tunnel**
 - FDS (four tendons)
 - FDP (four tendons)
 - FPL(one tendon)
 - Median Nerve



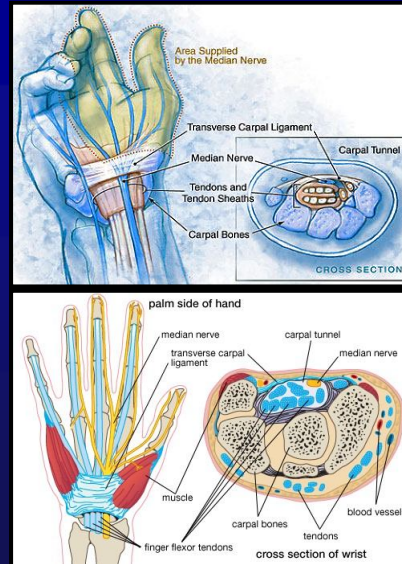
<http://carpal-tunnel.emedtv.com/carpal-tunnel-release--open-video/carpal-tunnel-anatomy-video.html>

3-01-1433

52

Carpal tunnel syndrome

- Median nerve & all flexor tendons except flexor carpi ulnaris & palmaris longus pass through carpal tunnel
- Swelling & inflammation can cause increased pressure in carpal tunnel resulting in decreased function of median nerve leading to reduced motor & sensation function in its distribution.



3-01-1433

<http://carpal-tunnel.emedtv.com/carpal-tunnel-release---open-video/carpal-tunnel-anatomy-video.html>

53

References

Neumann DA (2002). "Kinesiology of the Musculoskeletal System: Foundations for Physical Rehabilitation". Philadelphia: Mosby. Chapter 7 & 8.

Smith L.K., Weiss E.L., Don Lehmkuhl L. (1996). Brunnstrom's Clinical Kinesiology, 5th ed. Philadelphia: FA Davis. Chapter 6.

- **Loyola University Medical Center: Structure of the Human Body**
www.meddean.luc.edu/lumen/MedEd/GrossAnatomy/GA.html
 - An excellent site with many slides, dissections, tutorials, etc. for study of human anatomy. Describes motions caused by the muscles.

Huei Ming Chai

www.pt.ntu.edu.tw/hmchai/Kines04/KINupper/wrist/hand.htm

- Functions, stability and joint structure of wrist, hand complex; kinematics, muscle action and common injuries of the wrist.

- <http://www.getbodysmart.com/ap/muscularsystem/wristanddigits/menu/menu.html>
- <http://www.rad.washington.edu/academics/academic-sections/msk/muscle-atlas/upper-body/flexor-digitorum-profundus>
- <http://www.rad.washington.edu/academics/academic-sections/msk/muscle-atlas/upper-body/>

3-01-1433

54

Thanks for your attention

3-01-1433

55